Dry ingredients should be measured by volume and thoroughly mixed before the addition of any water. Half the water should be added, followed by mixing for approximately 5 minutes. The remaining water should then be added in small portions until a mortar of the desired consistency is reached. The total volume of water necessary may vary from batch to batch, depending on weather conditions. Mortar should be used within 30 minutes of final mixing, and "re-tempering," or adding *more* water after the initial mix is prepared, should not be permitted.

Modern Additives: In general, modern chemical additives are unnecessary and may, in fact, have detrimental effects. The use of antifreeze compounds is not recommended. They are not very effective with high lime mortars and may introduce salts, which will later cause efflorescence. A better practice is to warm the sand and water, and to protect the completed work from freezing. The use of air-entraining additives to resist frost action and enhance plasticity, are also discouraged, since the air has a detrimental effect on both bond and strength of the mortar. In areas of extreme exposure requiring high-strength mortars (see formula for "extreme weather exposure" under *Mortar Mix* section), air-entrainment of 10-16 percent may, however, be desirable. Bonding agents that increase the bond of the new mortar to the old should also be avoided. If the joint is properly prepared, there will be a good bond between the new mortar and the adjacent surfaces; chemical agents do not significantly improve this bond and are not a substitute for proper joint preparation. In addition, some of the agent will inevitably become smeared on the surface of the masonry and removal is very difficult.

Filling the Joint: Where existing mortar has been removed to a depth of greater than 1 inch, these deeper areas should be filled first, compacting the new mortar in several layers. The back of the entire joint should be filled successively by applying approximately ¼ inch of mortar, packing it well into the back corners. This application may extend for several feet. As soon as the mortar has reached thumb-print hardness, another ¼ inch layer of mortar—approximately the same thickness—may be applied. Several layers will be needed to fill the joint flush with the outer surface of the brick. It is important to allow each layer time to harden before the next layer is applied; most of the mortar shrinkage occurs during the hardening process and layering thus minimizes overall shrinkage.

The rate of hardening can be controlled by dampening the brick and the old mortar before beginning to fill the joint, but free water or excessive dampness in the joint should be avoided. Too much water will delay the tooling or cause excess shrinkage; too little water will be absorbed from the mortar before it is properly set, thus reducing bond strength.

When the final layer of mortar is thumb-print hard, the joint should be tooled to match the historic joint. Proper timing of the tooling is important for uniform color and appearance. If tooled when too soft, the color will be lighter than expected, and hairline cracks may occur; if tooled when too hard, there may be dark streaks called "tool burning," and good closure of the mortar against the brick will not be achieved.

If the old bricks have worn, rounded edges, it is usually best to recess the final mortar slightly from the face of the bricks. This treatment will help avoid a joint visually wider than the actual joint width; it will also avoid creation of a large, thin featheredge which is easily damaged, thus admitting water (figures 6 and 7).

After tooling, it is frequently necessary to remove excess mortar from the edge of the joint by brushing with a bristle brush.

"Aging" the Mortar: Even with the best efforts at matching the existing mortar color, texture, and materials, there will usually be a visible difference between the old work and the new, partly because the new mortar has been matched to the unweathered portions of the historic mortar. If the mortars have been properly matched, the best treatment for surface color differences is to let the mortars age naturally. Another reason for a slight mismatch may be that the sand is more exposed in old mortar due to the slight erosion of the lime or cement. Several methods of treatment have been attempted in an effort to overcome these differences. As with all work, however, any proposed treatment should be carefully tested prior to implementation.

Efforts to stain the new mortar to produce a color match should, in most cases, be avoided. Although such a process may provide an initial match, the old and new mortars may weather at different rates, leading to visual differences after a few seasons. In addition, the mixtures used to stain the mortar may be harmful to the masonry, for example, introducing salts into the masonry which can lead to efflorescence.

Cleaning: If repointing work is carefully executed, there will be little need for cleaning other than the small

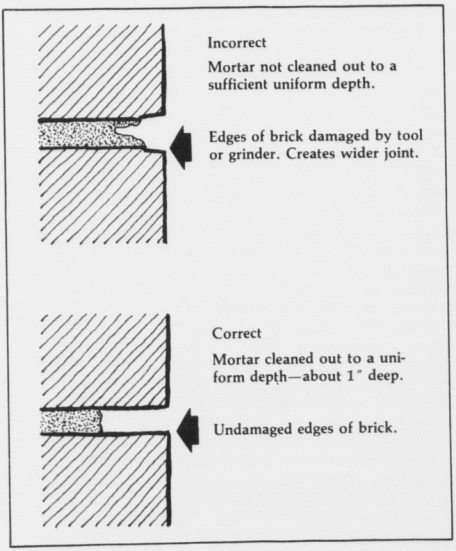
Incorrect
Mortar not cleaned out to a sufficient uniform depth.
Edges of brick damaged by tool or grinder. Creates wider joint.
Correct
Mortar cleaned out to a uniform depth—about 1" deep.
Undamaged edges of brick.

Figure 4. *Comparison of incorrect and correct preparation of mortar joints for repointing. Drawing: Robert C. Mack and David W. Look.*